Exhibit 27

HAMILTON STANDARD

Internal Correspondence

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CD 980
July 15, 1980
Rev. A-Aug. 1, 1980

Memorandum to: Mr. K. I. Harner

cc: Messrs. R. S. Dean, W. E. Fortmann, R. B. Goodman, J. F. Maher, J. P. Patrick, G. G. Thiem, E. B. Tobey

From: Dr. A. T. Chen

Subject: Dynamic Simulation and Analysis of the Nonflowing Surge Control for the Modified L-1011 APU

Abstract

The task of preparing a nonlinear simulation and dynamic analysis for supporting the L-1011 Auxiliary Power Unit (APU) surge control system redesign is documented in this memorandum. The design goal of the new system is to prevent the APU load compressor from going into any transient or steady state surge conditions for all feasible operational conditions and disturbances.

During the course of finalizing the new design the simulation/analysis has provided valuable information which helped in guiding the design modifications/improvements and provided some of the final design parameters. The final design consists of a surge control using a venturi flow sensor and a rate sensor control. Both controls are equipped with lever systems and the sensor signals are of the nonflowing type.

The simulation program for the new design has been prepared and verified against recent test data taken on an APU equipped with the current control system for the engine startup transient. The simulation and analysis indicate that the new design has acceptable stability as well as acceptable dynamic responses.

DYNAMIC SIMULATION AND ANALYSIS OF THE NONFLOWING SURGE CONTROL FOR THE MODIFIED L-1011 APU

July 15, 1980

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I. INTRODUCTION

This memorandum documents the dynamic simulation and setpoint analyses in support of the redesign effort of the L-1011 APU surge control system. Because starting the higher thrust Rolls-Royce engines of later models needs higher torque from the APU, Hamilton Standard initiated a redesign effort of the APU load compressor and the accompanying surge control system (see Figure 1 for original configuration of APU Load Compressor System).

The Environmental Control System (ECS) Design group came up with a new conceptual design for the modified APU surge control, see Reference 1. This design consists of a nonflowing surge control sensor equipped with a lever system and a lead-lag compensator using a laminar flow restrictor. The new design also reversed the direction of surge valve actuator motion, so that the surge valve opens when the control poppet opens giving inherently higher slew rate on a surge control demand as compared to the 1975 design whose valve opening rate was limited by fixed orifice flow when the control poppet is closed. The higher slew rate in the new design provided some hope that a rate sensor might not be needed for transient surge protection. An early version of the nonlinear simulation program was developed without the rate sensor model.

Preliminary results showed promising responses of the system following moderate transients. But when severer transients, such as two Air Turbine Machine (ATM) flows shut off simultaneously at a rate of full closure of ATM control valves within 0.050 second were considered the new design without the rate sensor failed to prevent the load compressor from going into temporary transient surge. A decision was made to include a rate sensor in the design.

The simulation program was revised to model the rate sensor and preliminary simulation results pointed out that the servo pressure feedback in the rate sensor had to be balanced out in order to obtain good transient performance. The study then proceeded to the setpoint analysis phase. The ECS Design group provided the lever ratios, pressure sensing bellow areas, and other relevant data. However, the spring rates and preloads and the dimensions of the laminar flow restrictors were decided through the setpoint analysis in order to achieve optimum dynamic responses for the transients considered.

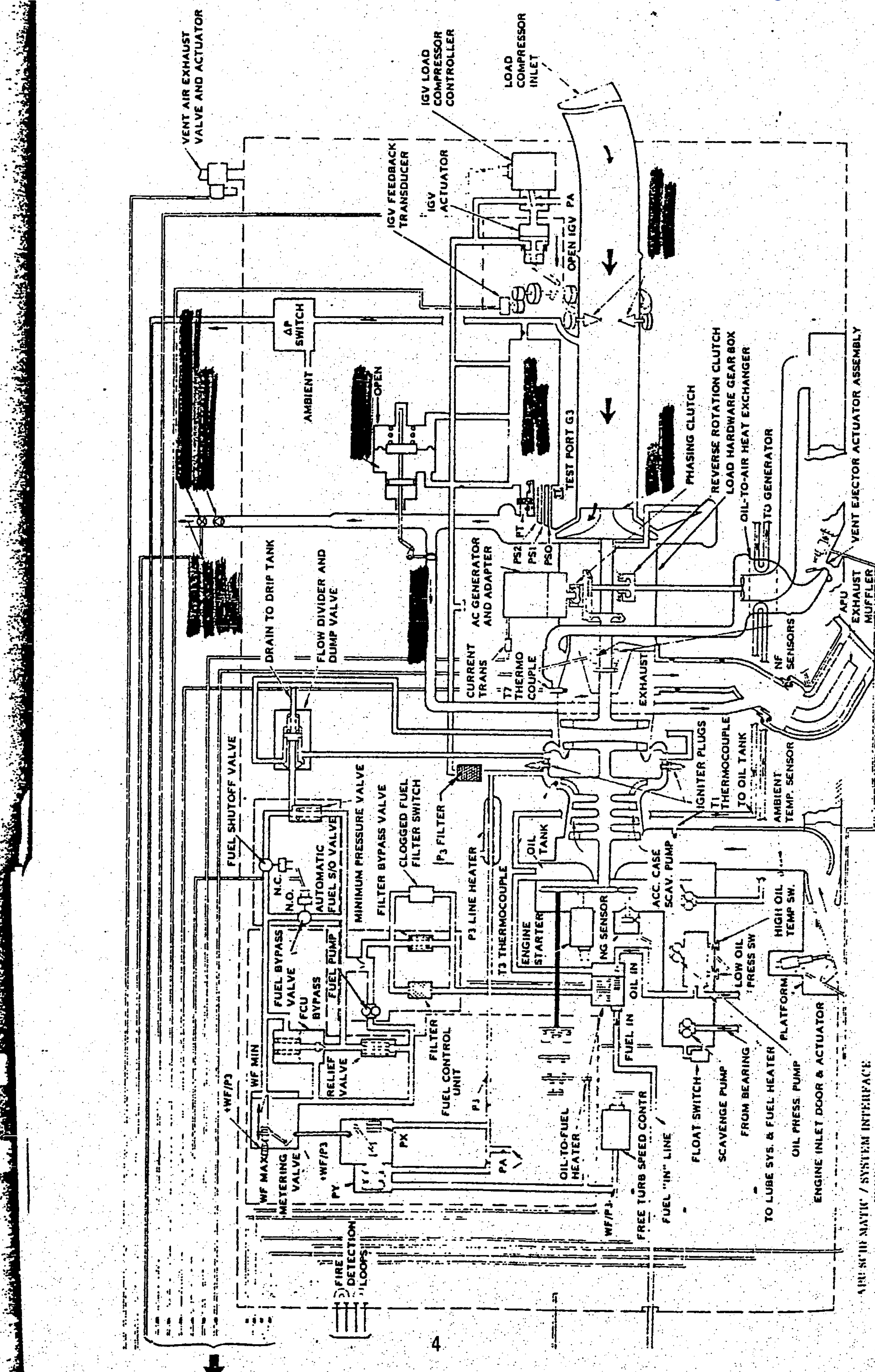

FIGURE 1. APU LOAD COMPRESSOR SYSTEM

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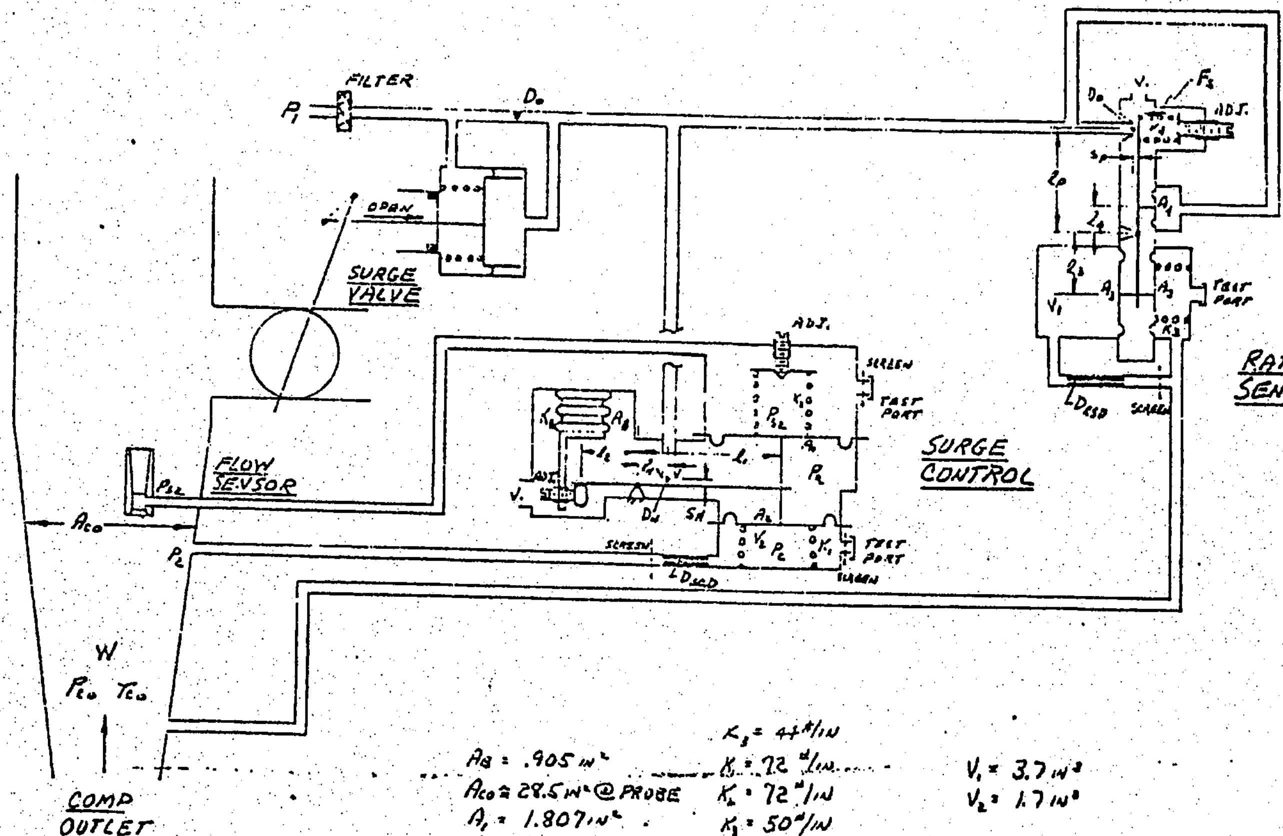
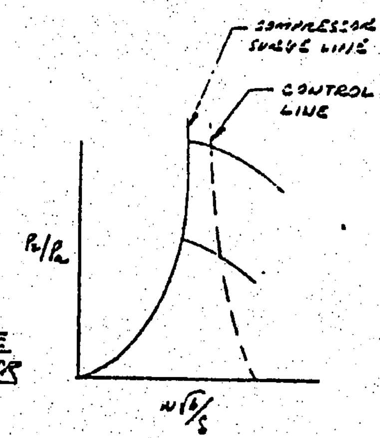
II. SUMMARY

The new design of the L-1011 APU surge control system has been analyzed and judged to be acceptable based on the best-estimate data of the modified load compressor. The new design along with parameter definitions (as shown in Figure 2) meets the design requirements to provide surge protection for most transients encountered in the operation of the APU.

Table 1 provides a list of transients and predicted peak and subsequent steady state compressor discharge pressures for several different operating conditions. The new design has comfortable surge margins on cold days and provides acceptable surge protection even for the most severe transients on a likely 103°F hot day. However, on the extremely hot 130°F day the compressor transient surge margin is marginal during the severe transients.

A verification against available test data of current design on an engine startup transient as detailed in Section IV 7 provides confidence on the validity of the simulation.





FLOW SENSOR CHARACTERISTIC

$$\frac{W\sqrt{\theta}}{\delta} \approx 348\sqrt{1-\frac{P_{S2}}{P_2}}$$

CONTROL CHARACTERISTIC

$$\frac{P_{S2}}{P_2} = \frac{1 - \frac{A_2}{K}\left[\frac{A_B l_2}{A_2 l_1} - \left(\frac{A_1 - A_2}{A_2}\right)\right]}{1 + \left(\frac{A_1 - A_2}{A_2}\right)}$$

$\frac{A_B l_2}{A_2 l_1} = .172$ $\frac{A_1 - A_2}{A_2} = .083$

A_B = .905 IN²	K_s = 44#/IN	V_1 = 3.7 IN³
A_{CO} ≈ 28.5 IN² @ PROBE	K_1 = 72 #/IN	V_2 = 1.7 IN³
A_1 = 1.807 IN²	K_2 = 72#/IN	
A_2 = 1.668 IN²	K_3 = 50#/IN	
A_3 = 1.103 IN²	K_4 = 25 #/IN	
A_4 = .19 IN²	l_N = .512 IN	
	l_P = 1.63 IN	
	l_1 = 1.792 IN	
D_N = .23 IN	l_2 = .568 IN	
D_o = .04 IN	l_3 = 1.10 IN	
D_P = .23 IN	l_4 = .43 IN	
D_{RSD} = .010 DIA x .04 LG		
D_{SCD} = .010 DIA x .10 LG	S_N = .016 IN	
F_S = .7#	S_P = .063 IN	

FIGURE 2. SURGE CONTROL SYSTEM SCHEMATIC

SURGE CONTROL SYSTEM
MODIFIED APU

REV 6/20/80

SHEET 2
REV 5/29/80, 6/11/80
CAGLENN 5/20/80

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TABLE 1

Summary of peak and steady state compressor discharge pressures through operational transients.

Transients / Operating Conditions	Starter Flow Shutoff	2 ATM Flow Shutoff	2 Pack ECS Flow Shutoff	2 Pack ECS Flow Shut Via Isolation
103° Day Sea Level Max Mode (P_{surge} = 51.0 psia)	P_{comax} = 50.73 $P_{s.s.}$ = 48.1 1 RS cycle*	P_{max} = 50.76 $P_{s.s.}$ = 48.2 1 RS cycle	P_{max} = 49.33 $P_{s.s.}$ = 48.7 3 RS cycles	P_{max} = 50.07 $P_{s.s.}$ = 48.6 1 RS cycle
-25° Day Sea Level Max. Mode (P_{surge} = 67.1 psia)	P_{max} = 64.45 $P_{s.s.}$ = 62.4 1 RS cycle	P_{max} = 65.49 $P_{s.s.}$ = 62.5 2 RS cycles	P_{max} = 63.97 $P_{s.s.}$ = 62.8 6 RS cycles	P_{max} = 64.0 $P_{s.s.}$ = 63.2 3 RS cycles
130° Day Sea Level Max. Mode (P_{surge} = 48.1 psia)	P_{max} = 48.05 $P_{s.s.}$ = 45.3 No RS cycle	P_{max} = 48.1 $P_{s.s.}$ = 45.3 1 RS cycle	P_{max} = 46.18 $P_{s.s.}$ = 45.4 2 RS cycles	P_{max} = 47.76 $P_{s.s.}$ = 45.5 1 RS cycle
15,000 Ft & 67°F Max. Mode (P_{surge} = 31.7 psia)	✦	✦	P_{max} = 31.4 $P_{s.s.}$ = 29.95 2 RS cycles	P_{max} = 31.35+ $P_{s.s.}$ = 29.85 No RS cycle
103° Day Sea Level Min. Mode Operation (P_{surge} = 33.8 psia)	✦	✦	P_{max} = 33.05 $P_{s.s.}$ = 31.1 1 RS cycle	P_{max} = 33.41 $P_{s.s.}$ = 31.3 No RS cycle

\+ 1 pack ECS flow shutoff transient

* n RS cycles mean the rate sensor opens and closes n times through the transient.

✦ Transients not encountered in normal operation

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III. CONCLUSIONS AND OTHER RESULTS

III.1 CONCLUSIONS

1) The analysis of the final design using the best-estimate data indicates that the system meets the design requirements to provide surge control to the L-1011 APU load compressor.

2) On a 103°F hot day, the system would hold the peak compressor discharge pressure about .25 psid below the surge point for the starter flow shutoff and the 2 ATM flow shutoff transients.

3) For the -25°F cold day the transient surge margin is increased to about 2.5 psid below the surge point.

4) On a 130°F hot day the surge margin becomes very close to zero for a time duration of less than .1 second. This marginal condition is judged acceptable because a 130°F day is unlikely and very few surge cycles if any will occur for the short time duration.

5) At high altitude (15K), the 2 pack ECS flow shutoff transient and the APU isolation valve closure transient when supplying one ECS pack can be controlled without much problem. However, the APU isolation valve closure transient starting with 2 pack ECS flow transient surge margin is approximately zero. This is also judged acceptable because it is unlikely and also of very short time duration.

6) In the min. mode operation, the surge control provides adequate transient surge protection for the 2 pack ECS flow shutoff and the isolation valve closure transients.

7) In the engine startup transient, the new design provides good control. However, with the rate sensor time constant increased to about ten times of the base case time constant the transient would go through a period of oscillation for about ten seconds at a frequency of 2.5 cycles per second. This altered transient resembles recent test data of the present control system and illustrates the potential stability problem if the rate sensor is made too responsive.

III.2 OTHER RESULTS

1) Corrected starter flows of 110 ppm were also evaluated at 103°F and 59°F day conditions. The transient peak pressure for the 103°F day case is slightly higher than that obtained for the 97 ppm corrected starter flow case but still less than the surge point. The 59°F day 110 ppm corrected starter valve shutoff results in a peak pressure of 55.7 psia which is .3 psi below the surge value. The transient response characteristics of the 110 ppm corrected flow starter valve shutoffs are similar to that shown in Figure 7.

2) The 2 pack ECS flow shutoff transient surge margins are larger than those for the 2 ATM flow shutoffs. This is due to the action of the rate sensor which anticipates the compressor discharge pressure increase to reduce the saturated actuator servo pressure and begin to open the surge valve before the steady state surge control point is reached. In the field the setpoint calibration is important to assure good functioning readiness for the rate sensor to provide the needed protection. In the case of rate sensor

III.2 OTHER RESULTS --continued

malfunction, e.g., no R.S. opening, the 2 pack ECS shutoff transients become severest in terms of compressor discharge pressure peaking.

3) Due to the close resemblence of the simulated engine startup transient and the test data as detailed in Section IV 7, it is plausible to place confidence on the validity of the simulation. Additional correlation to test data with the original hardware or with the new design is recommended to improve this confidence level.

IV. ANALYSIS

This section documents the analysis results obtained in this study. A summary of the results is provided in Section II. The discussion of analysis is divided into the following subsections:

1) Simulation and data preparation.

2) 103°F day sea level (S.L.) max. mode transients.

3) -25°F day S.L. max. mode transients.

4) 130°F day S.L. max. mode transients.

5) Max. mode ECS transients at 15,000 ft. and 67°F.

6) 103°F day S.L. min. mode ECS transients.

7) 103°F day S.L. min. mode to START mode transient.

IV.1 Simulation and Data Preparation

A nonlinear FORTRAN simulation program called LASCN (for L-1011 APU Surge Control New design) and the accompanying data file called LASCD were prepared for this analysis. The LASCN program utilizes available process models and supporting routines from the Control Dynamics program library. Process models called in this program include CMPFLO, LMFLO, PRVOL and ACTUAT subroutines for the simulation of compressible flow, laminar flow, pressure volume and actuator responses respectively. A supporting subroutine UNLINR was written in this study to provide linear interpolation and controllable extrapolation along with the slope of adjacent data. Appendix B.1 provides further detail description of the program LASCN.

To facilitate convenient execution of the program, several options and separated data arrays are provided in LASCN and LASCD. For example, the compressor pressure ratio versus corrected flow data for different ambient temperatures and for both MAX. and MIN. mode operations are read into the program input arrays. Depending on the options selected the program will use appropriate data from these arrays in a particular simulation. Appendix B.2 provides a concise description of each input item and the best-estimate data for most of them.

Because of the IBM computer TSO (Time Sharing Option) setup, the program execution will automatically run the base case in the data file LASCD. It has been decided that the 103°F day sea level max. mode starter flow is a proper condition for the calibration of the APU surge control systems. Therefore the LASCD data file is set up to run the starter flow shutoff transient as the first case in each job submission.

Figure 2, also Reference 2, provides the schematic diagram of the new design and the design parameters which are studied here. A listing of the LASCN program and the LASCD data file is attached as Appendix B.3. Figures 3, 4, 5, and 6 provide the compressor maps for both the max. mode and min. mode operations. Table 2 shows the effective surge valve area versus the actuator stroke. Table 3 provides the friction torque and moment-arm of the surge valve/actuator assembly reflected to the actuator piston. Table 4 provides the surge valve aerodynamic torque and force versus the actuator stroke data. Other data are obtained from References 2, 3, 4 and 5.

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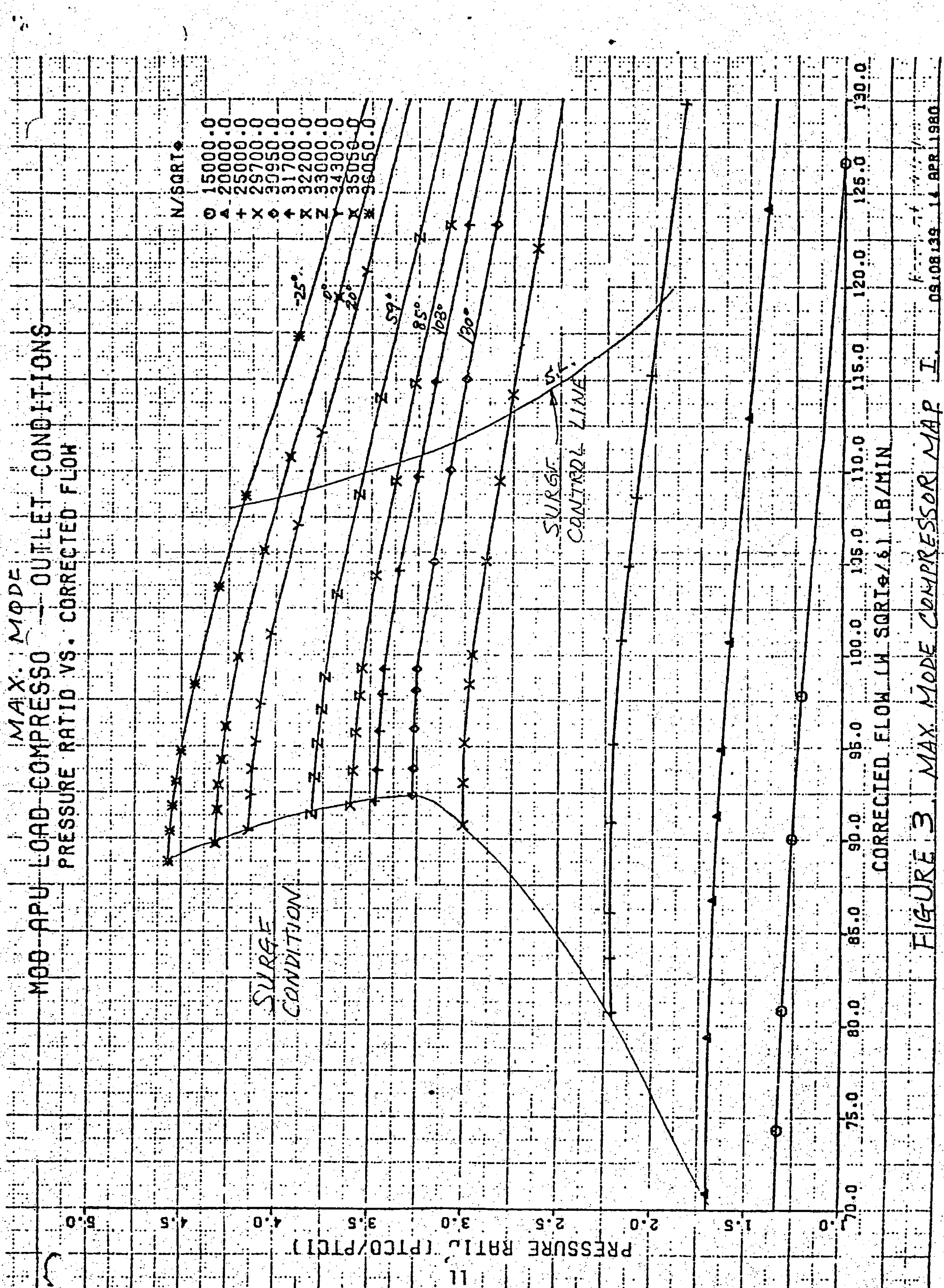

FIGURE 3 MAX MODE COMPRESSOR MAP I

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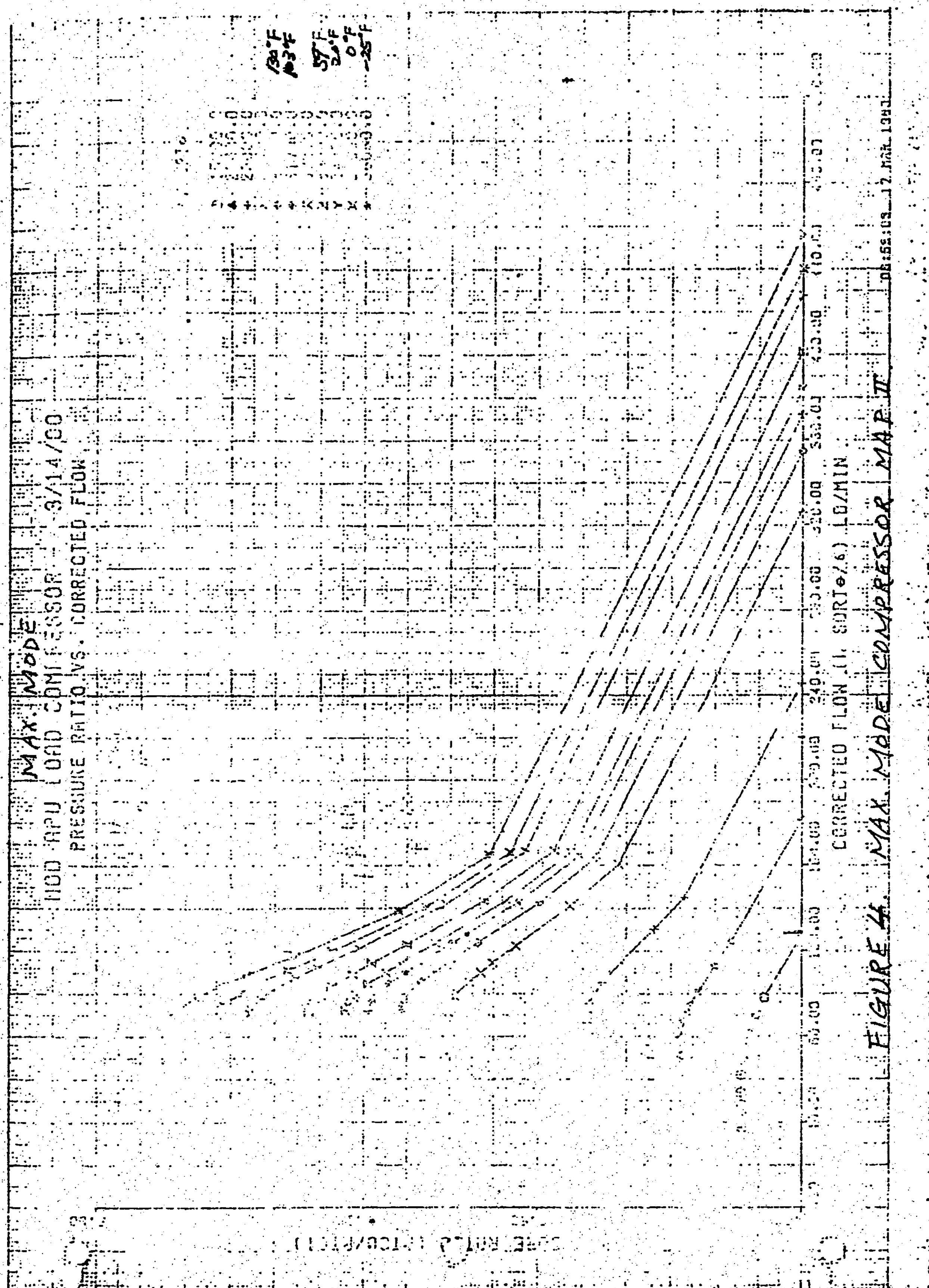

FIGURE 4. MAX MODE COMPRESSOR MAP III

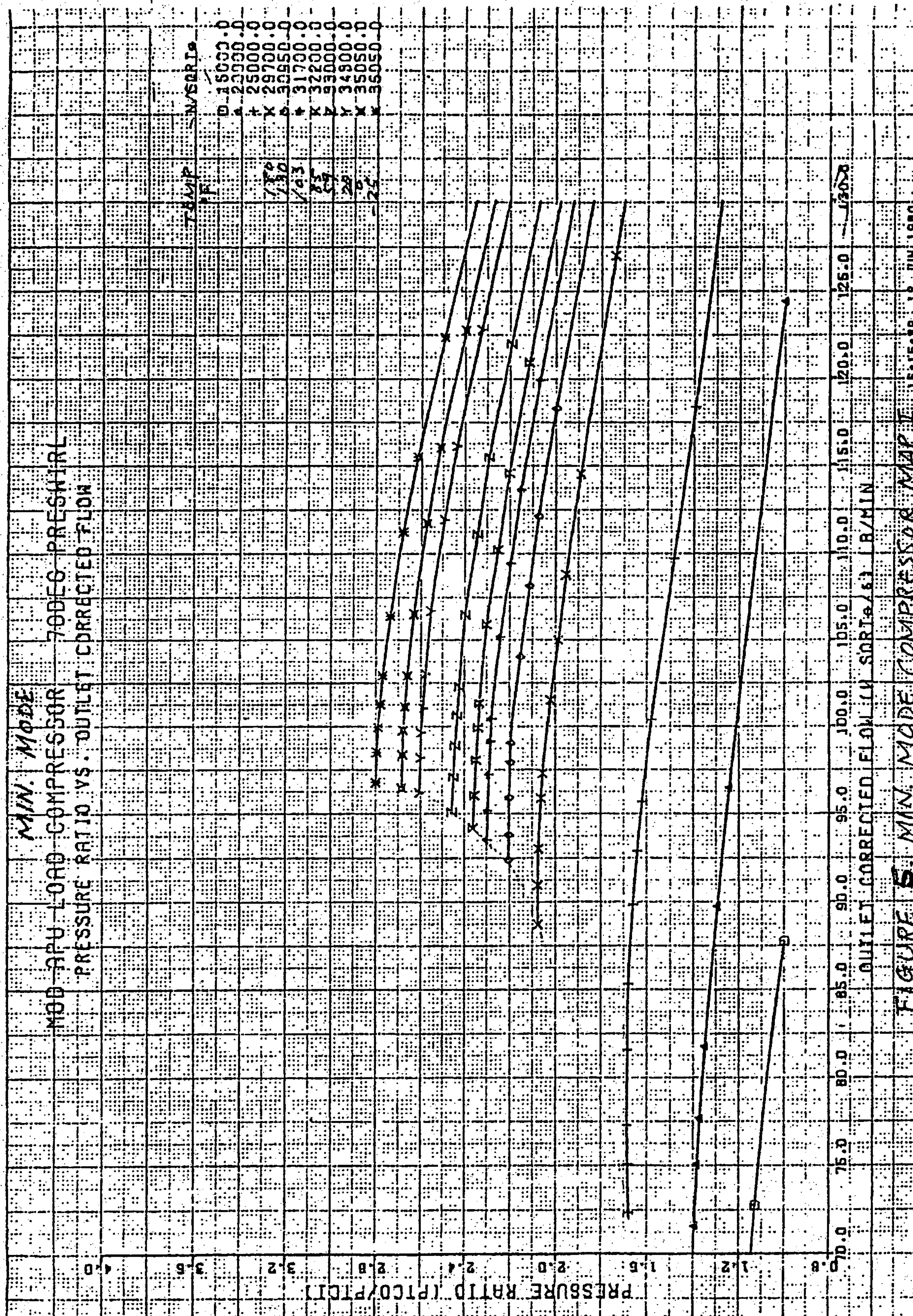

FIGURE 5: MIN. MODE COMPRESSOR MAP I

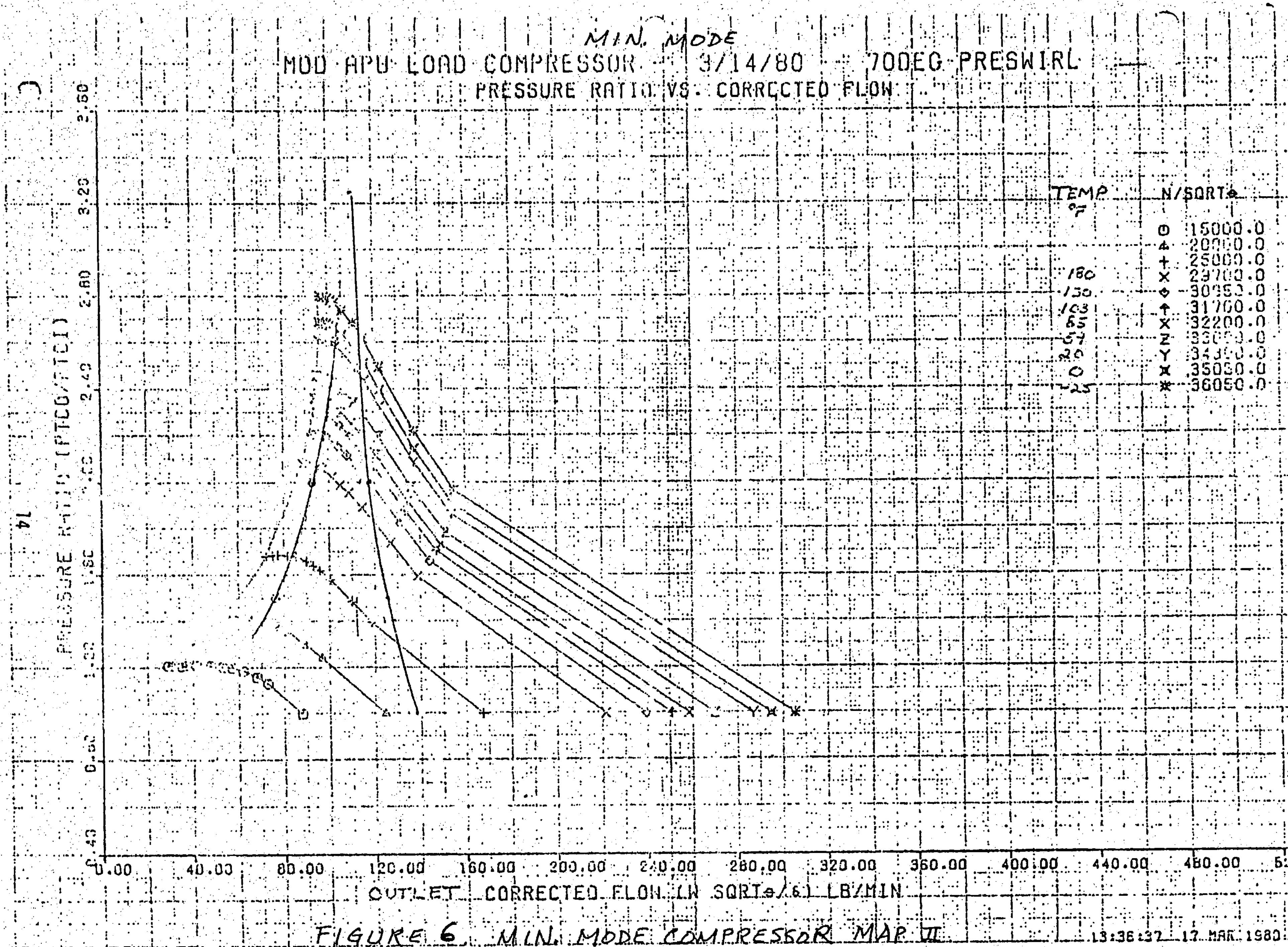

FIGURE 6 MIN. MODE COMPRESSOR MAP II

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TABLE 2

Effective Surge Valve Area Versus Actuator Stroke

Valve Angle (°)	Actuator Stroke (in)	$\frac{W_{sv}\sqrt{T_u}}{P_u D^2}$ * (lb/min)	Effective Area A_{eff} (in^2)
0	1.8	0.0	0.0
10	1.6	0.4	0.295
20	1.4	1.3	0.958
30	1.2	2.5	1.84
40	1.0	4.6	3.39
50	0.8	7.35	5.41
60	0.6	10.9	8.03
70	0.4	16.4	12.08
80	0.2	20.6	15.17
90	0.0	22.9	16.87

*Reference 5

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TABLE 3

Surge Valve Friction Torque and Moment Arm
Versus Actuator Stroke*

Valve Angle (°)	Actuator Stroke (in)	Moment Arm (in)	Friction Torque 103°F Day (in-lb)	Friction Torque -25°F Day (in-lb)
90	0.0	1.1189	3.0	4.2
80	0.2	1.2026	3.4	5.2
70	0.4	1.2622	4.0	7.0
60	0.6	1.2906	6.0	9.0
50	0.8	1.2622	8.5	12.5
40	1.0	1.2026	10.0	15.2
30	1.2	1.1189	11.9	17.5
20	1.4	1.0175	13.3	19.2
10	1.6	0.9036	14.3	20.0
0	1.8	0.7809	15.0	21.2

*Reference 7

TABLE 4

L-1011 APU Surge Control Valve Aerodynamic Load Data*

Valve Angle (°)	Xact Present Design	Xact New Design	Moment Arm (in)	Pco = 63 psia PA/Pco=.2333		Pco = 45 psia PA/Pco=.3267	
				Torque (in-lb)	Force / Pco	Torque (in-lb)	Force / Pco
0	0.0	1.8	.7809	0.0	0.0	0.0	0.0
10	0.2	1.6	.9036	16.0	.281	11.5	.283
20	0.4	1.4	1.0175	30.5	.476	22.0	.480
30	0.6	1.2	1.1189	46.0	.653	33.0	.655
40	0.8	1.0	1.2026	59.0	.779	42.5	.785
50	1.0	0.8	1.2622	75.0	.943	50.0	.880
60	1.2	0.6	1.2906	94.0	1.156	66.5	1.171
70	1.4	0.4	1.2622	113.0	1.421	80.0	1.408
80	1.6	0.2	1.2026	74.0	.977	56.0	1.035
90	1.8	0.0	1.1189	0.0	0.0	0.0	0.0

*Reference 8

IV.2 103°F Day Sea Level Max. Mode Transients

Four transients are simulated here. These include: (1) starter flow shutoff, (2) 2 ATM flow shutoff, (3) 2 ECS pack flow shutoff and (4) 2 ECS pack flow turned off via APU isolation valve closure. The starter flow shutoff transient is run as the first case for each computer job execution to properly set the preload on the surge control lever system for the calibrated corrected flow rate of 111.0 lb/min (ppm). The steady state starter corrected flow is set at 97.0 ppm and the shutoff time is 0.5 second. Figure 7 shows the transient responses of 10 key parameters in the simulation. All flows discussed here and plotted are corrected flows.

At 0.15 second from simulation time = 0, the corrected ECS flow (starter flow) starts ramping down and reaches zero flow 0.5 second later. The reduction in outgoing flow causes the duct pressure to increase which drops the compressor discharge flow. The decrease in flow causes the pressure difference from the surge control venturi flow sensor to drop and the flapper valve to open wider. Also the pressure difference of the rate sensor builds up and exceeds the set-point. This results in the opening of the rate sensor poppet valve. These two effects combine to dump the actuator servo air quickly which results in rapid decrease of servo pressure, and subsequent actuator motion which opens the surge valve. The surge valve flow increases rapidly to relieve the pressure increase and prevent surge. After the transient is over the system returns to near the original control conditions with the surge flow replacing the starter flow.

Transient #2 is simulating the case of shutting off 2 ATM flow simultaneously in 0.050 second, see Figure 8. The initial steady state 2 ATM flow is 244 ppm real flow, Reference 6, or 85.5 ppm corrected flow. In this transient, the rate of change of the disturbance and therefore the duct pressure is high. The rate sensor builds up the pressure difference and opens its flapper quickly to reduce the servo pressure. The surge valve opens widely and quickly to stop the duct pressure increase. The initial control action over-corrects yielding higher compressor flow and lower pressure than the steady state surge control values. The rate sensor closes after a short while when the pressure difference falls below the setpoint. Meanwhile the surge control goes through a similar correcting cycle. The closure of the rate sensor flapper and the surge control flapper reverses the pressure and flow trend. At about 0.3 second after the closure of rate sensor flapper both the rate sensor and the control sensor go through another action cycle. The system settles down to steady state control quickly after that. The transient surge margin, i.e., the difference in surge pressure and the peak compressor discharge pressure, is about 0.24 psid for this transient.

Transient #3 is the case where 2 ECS pack steady state corrected flow of 128 ppm is shut off in 0.5 second simultaneously, see Figure 9. The initial flow rate is higher than the steady state surge control value so the surge control flapper is initially closed. This results in a saturation condition with the servo pressure in the actuator equal to the supply pressure of 88 psia. Because of this saturation condition, the servo pressure must be reduced to the actuator force balance point before the valve will begin to open which requires a time period of 0.2 second after the transient is initiated. Since the disturbance comes in a slower rate, although larger magnitude, as compared to the 2 ATM shutoff transient the rate of duct pressure increase is also lower. Because of the lower starting pressure due to higher flow and slower disturbance rate,

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the peak compressor discharge pressure is lower than for the 2 ATM flow shutoff. The rate sensor goes through 3 action cycles while the control settles to the steady state surge control point.

Figure 10 depicts transient #4 whereby the APU isolation valve (i.e., bleed air shutoff valve) is closed in 2 seconds from a steady state 2 ECS pack flow condition. The ECS flow control valves are assumed to maintain constant opening during the transient. The closure of APU isolation valve creates two adjacent control volumes in the duct between the compressor discharge and the ECS flow control valves. The first volume is a small one of about 1.75 ft^3 defined as the duct space from the compressor discharge to the isolation valve. The second volume consists of the remaining portion of the original duct volume of about 25 ft^3. The closure of the isolation valve actuator is assumed to occur in a linear fashion over a period of 2.0 seconds. The flow through the isolation valve is calculated as a result of the valve area and the pressure difference between these two volumes. The rate of change of the resulting flow is smaller than the previous transient. This allows sufficient time for the surge control to respond and the actuator to come out off the saturation condition. However, the pressure increase steepens when the isolation valve is about 30% or 40% closed. This activates the rate sensor to help in relieving the pressure increase. After this rate sensor action cycle and further small control sensor adjustment the system settles to its steady state surge control point.

Because the first volume is much smaller (1/15) than the original duct volume analyzed for the previous transients, the rate of change of pressure for a given flow change is fifteen times larger. As a result this transient is most critical in terms of selecting an acceptable rate sensor time constant and preload. If the rate sensor is too sensitive (larger time constant and/or smaller preload), instability due to the rate sensor action occurs in this small volume.

The impacts of the friction variation on system stability and transient surge margins are small, see Figures 11 and 12. Figure 11 shows the 2 ATM flow shutoff transient with 10% of the base case friction in the actuator and surge valve assembly. This transient has good stability and slightly improved transient surge margin. Figure 12 depicts the same transient with 150% friction. This transient has about the same stability and transient surge margin as the base case.

IV.3 -25°F Day Sea Level Max. Mode Transients

Again, four transients were studied for the -25°F day max. mode operation at sea level. These are the same transients as discussed in the previous section except that the ambient temperature is -25°F. The compressor pressure ratios of this cold day are higher than that of the 103°F day case for all corrected flows as depicted in Figures 3 through 6. The surge margin at steady state is also higher for the cold day.

The most distinct difference in the dynamic responses between similar transients on a 103°F day and on a -25°F day is the poorer stability of the -25°F day cases because of the higher gain at this operating condition. In general, the -25°F day case takes longer and more control action and/or rate sensor cycles to settle the transients. For example, the 2 ATM shutoff transient needs 2 rate

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sensor cycles and the 2 ECS pack shutoff transient needs 6 rate sensor cycles for the cold day case, see Figures 13 and 14, as compared to 1 cycle and 2 cycles for the corresponding transients of the 103°F day case.

The isolation valve closure transient on a -25°F day is the most critical from a stability point of view and dictates the rate sensor time constant and preload. Longer rate sensor time constant or smaller preload that would give acceptable stability for the 103°F day case could produce unstable limit cycle type response for the -25°F day APU isolation valve closure. This is due to the higher gain resulting from the steeper slope of compressor pressure ratio versus corrected flow relation for the cold day case. The results with the baseline rate sensor time constant and preload that give acceptable stability for the -25°F day APU isolation valve turnoff are illustrated in Figure 15.

The cold day transients settle to new steady states with peaking pressures comfortably below the surge condition. The impacts on the system stability due to actuator/valve friction variation were also analyzed for the cold day isolation valve closure transient, see Figures 16 and 17. The case of 10% friction has almost identical responses as the base case and the case of 150% friction has slightly poorer but still acceptable stability.

IV.4 130°F Day Sea Level Max. Mode Transients

The four transients previously described were also analyzed for the 130°F hot day conditions. In general, these transients have somewhat better stability than the 103°F day transients. Figure 18 shows the 2 ATM flow shutoff transient. The peak compressor discharge pressure reaches 48.1 psia which is the predicted surge pressure point. The time period that the pressure is above 47 psia is less than 0.1 second so that if any transient surge does occur it will probably be only 1 or 2 cycles. This 130° day case is unlikely so this condition is judged to be acceptable. The other transients are very similar to those for 103°F day conditions.

IV.5 Max. Mode ECS Transients at 15,000 Ft. and 67°F

Two transients involving ECS operation at high altitude are analyzed. These are 1 ECS pack flow shutoff, Figure 19, and 2 ECS pack flow shutoff transients, Figure 20. Again these two transients have good stability and their responses are quite similar to those of 103°F day. Both transients have acceptable stability and transient surge margin.

IV.6 103°F Day Sea Level Min. Mode Transients

The 2 ECS pack flow shutoff and the APU isolation valve closure transients are analyzed for min. mode operation. Figure 21 depicts the 2 ECS pack shutoff case which has transient responses quite similar to the max. mode transient at altitude. Again the min. mode transients have acceptable stability and transient surge margin.

IV.7 103°F Day Sea Level Min. Mode to START Mode Transients

This is the transient simulating the responses of the APU load compressor and control system during the startup process of a main engine. The APU is switched from MIN to MAX mode for starting to provide higher pressure pneumatic supply. Figure 22 shows the transient with the base design parameters as presented in Table B.1. The first five seconds of the simulation are initializing time for the simulation to reach the MIN mode steady state values. The disturbance of this transient which occurs at a time of 5 seconds is the Inlet Guide Vane (IGV), opening from 20° to 80° through a time constant of 3 seconds. The compressor discharge pressure increases from the MIN mode steady state level of 30.6 psia towards the START mode steady state level. Due to the transient pressure lag during the IGV transient position change, there are transient changes in corrected compressor discharge and ECS flows that cause minor changes in the surge control flapper and valve actuator position. The rate of change of pressure activates the rate sensor for one cycle. This affects the surge flow transient temporarily and the surge control continues to modulate and maintain the flow and pressure close to the designed steady state surge control condition. The stability of the system during this transient is fairly good.

Since some recent test data of the current design for this transient are available, see Figure 23, an attempt was made to verify the computer program with a simulation of this new design model fitted with parameters close to those used in the test. Figure 24 shows the responses of new system to the same transient with the rate sensor time constant increased from 0.04875 second to 0.4875 second which is close to the average of the current system. It is evident that the simulation bears a close resemblence to the current system test results. This good verification provides confidence on the validity of the simulation program. Further verification with additional test data should be done to gain a higher degree of confidence.

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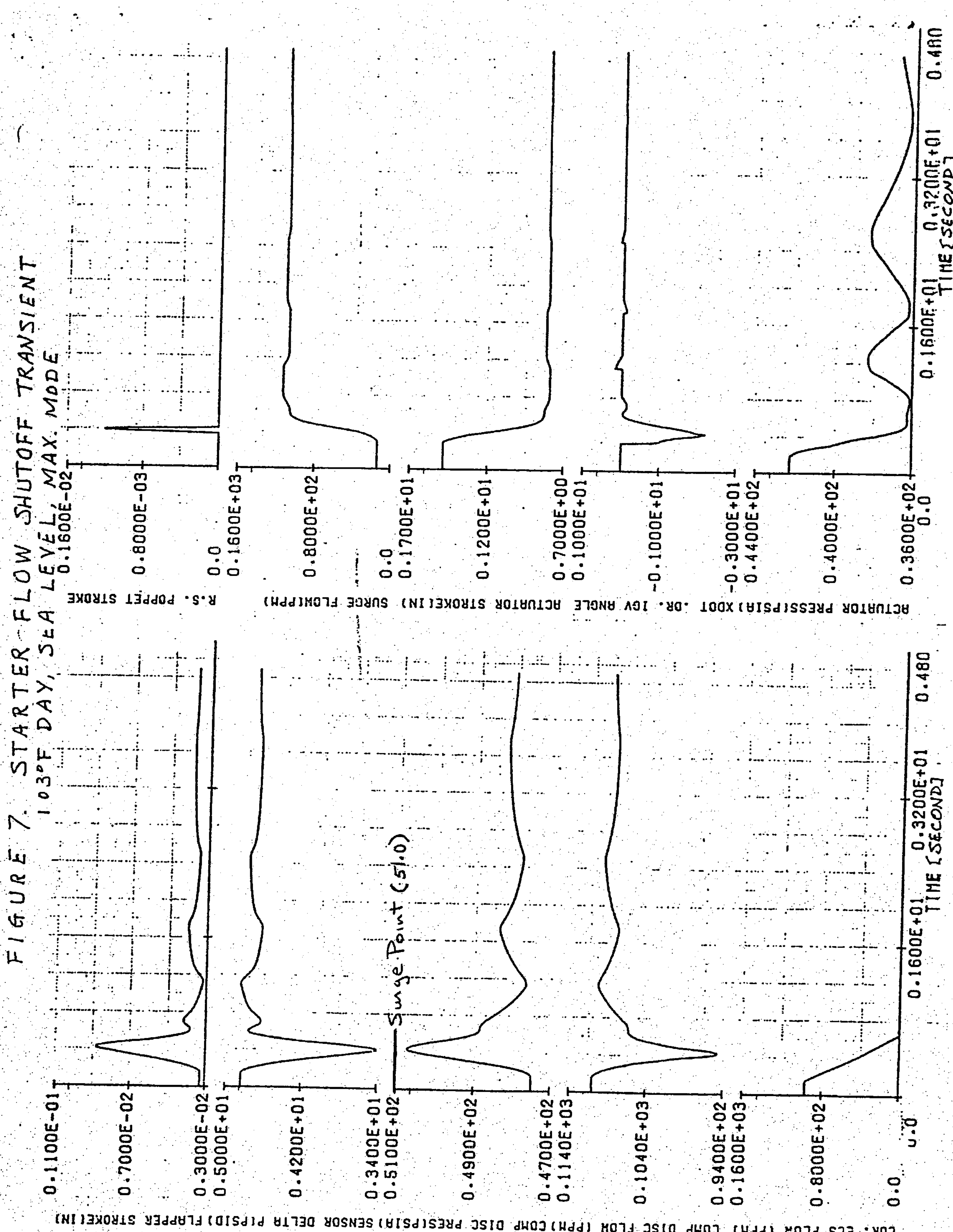

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FIGURE 8. TWO ATA FLOW SHUTOFF TRANSIENT
103°F DAY, SEA LEVEL. MAX. MODE

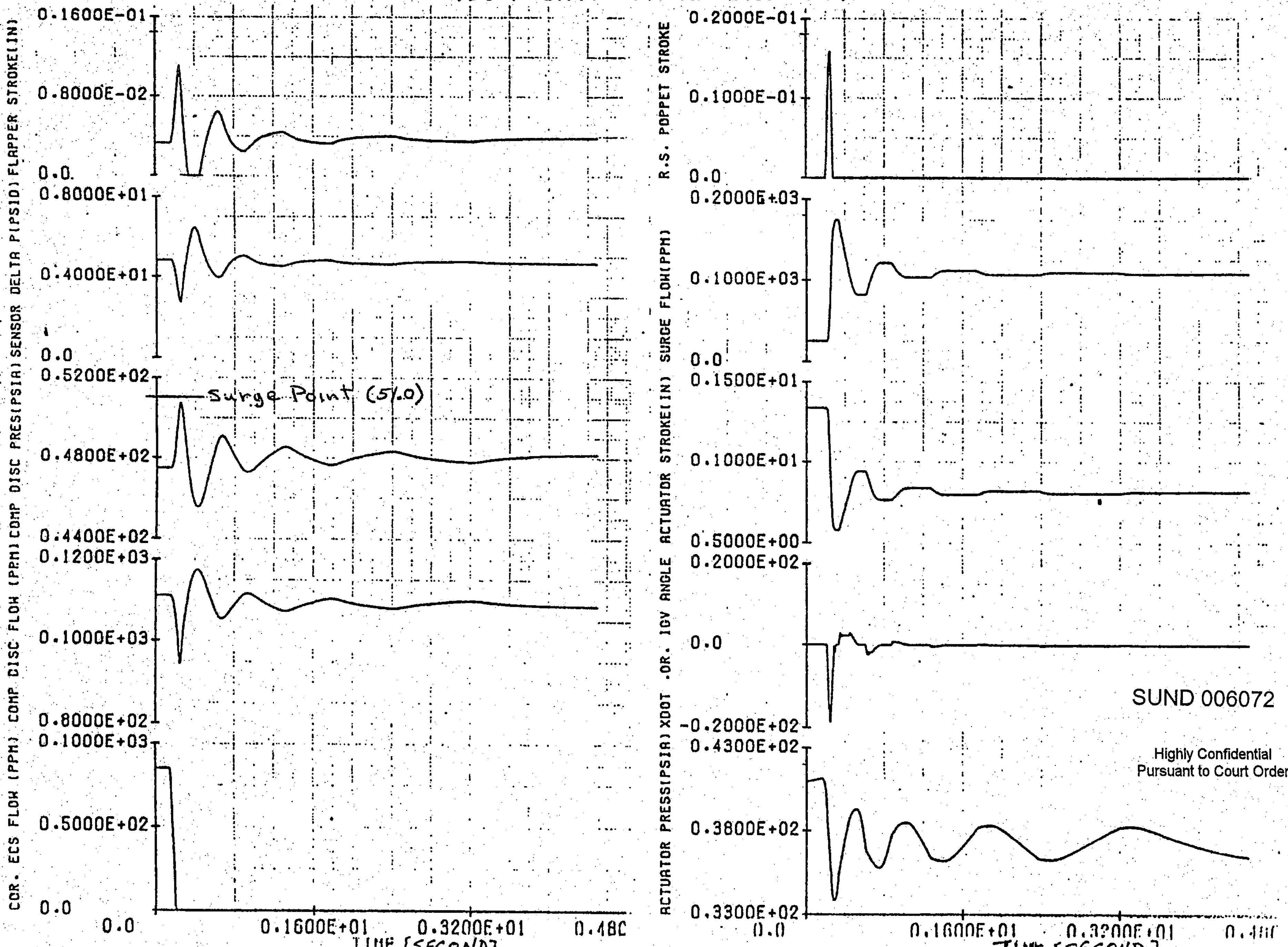

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FIGURE 9. TWO PACK ECS FLOW SHUTOFF TRANSIENT
103°F DAY. SEA LEVEL. MAX. MODEL

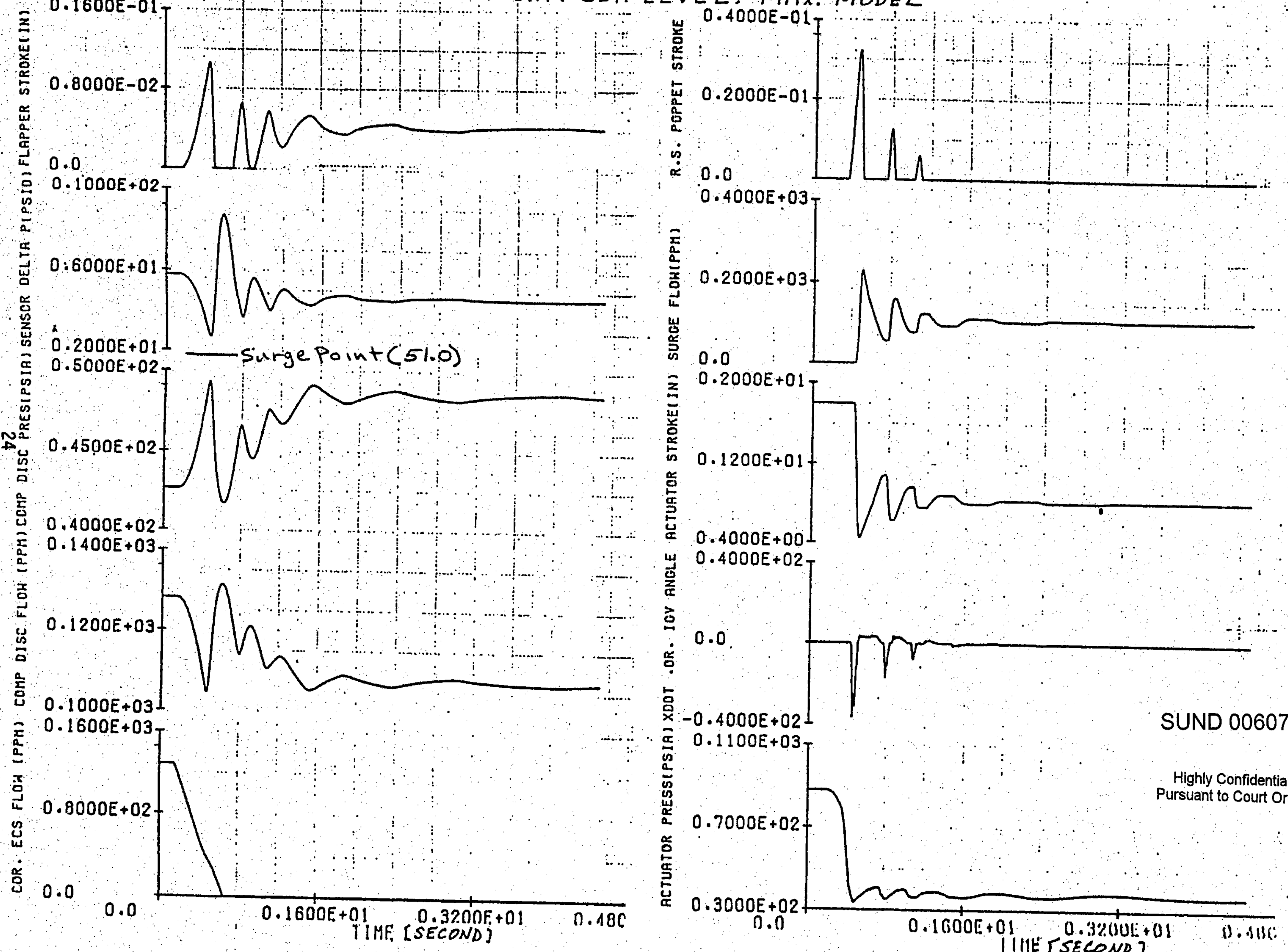

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FIGURE 10. APU ISOLATION VALVE TURNOFF TRANSIENT
103°F DAY, SEA LEVEL, MAX. MODE

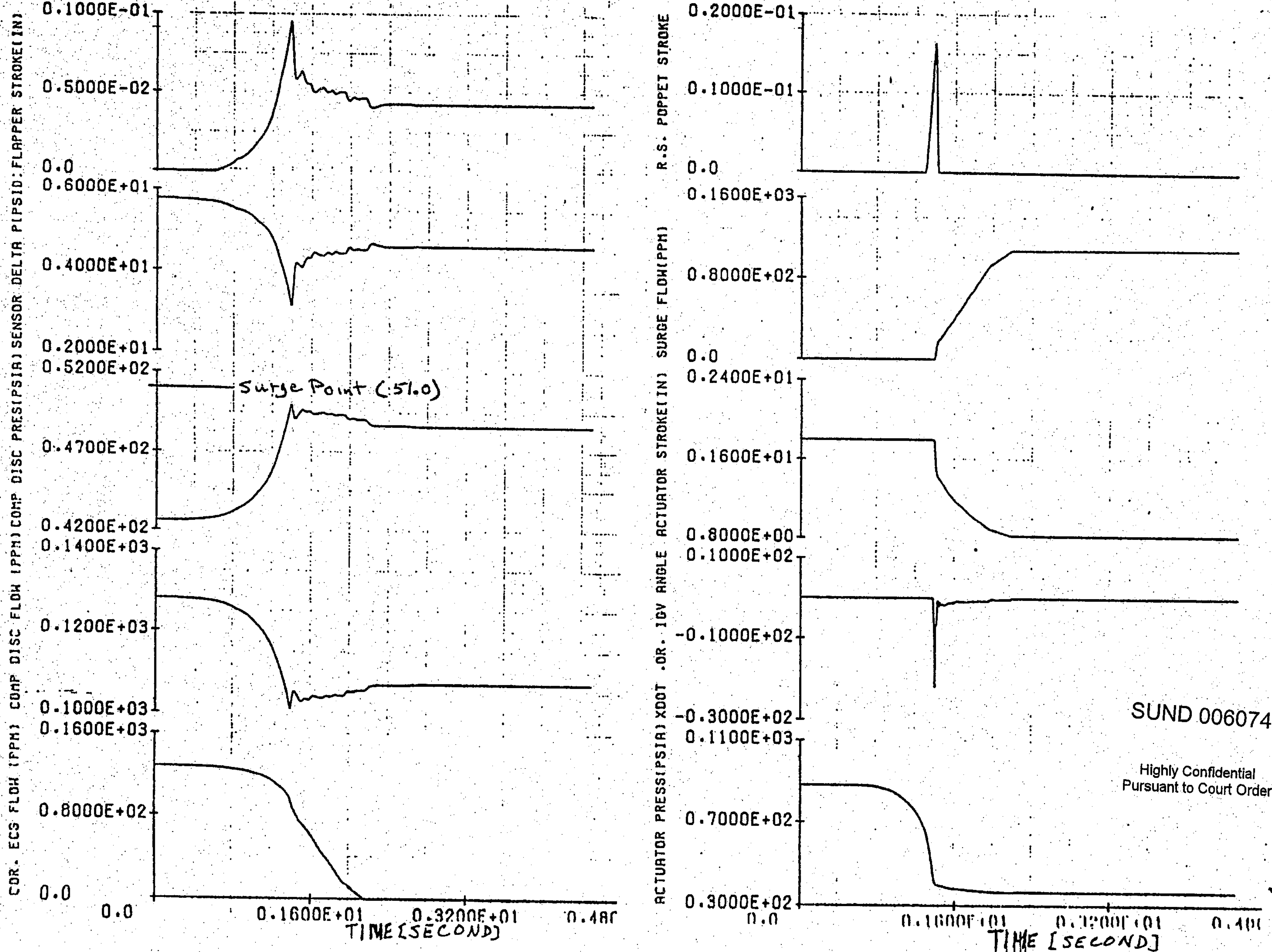

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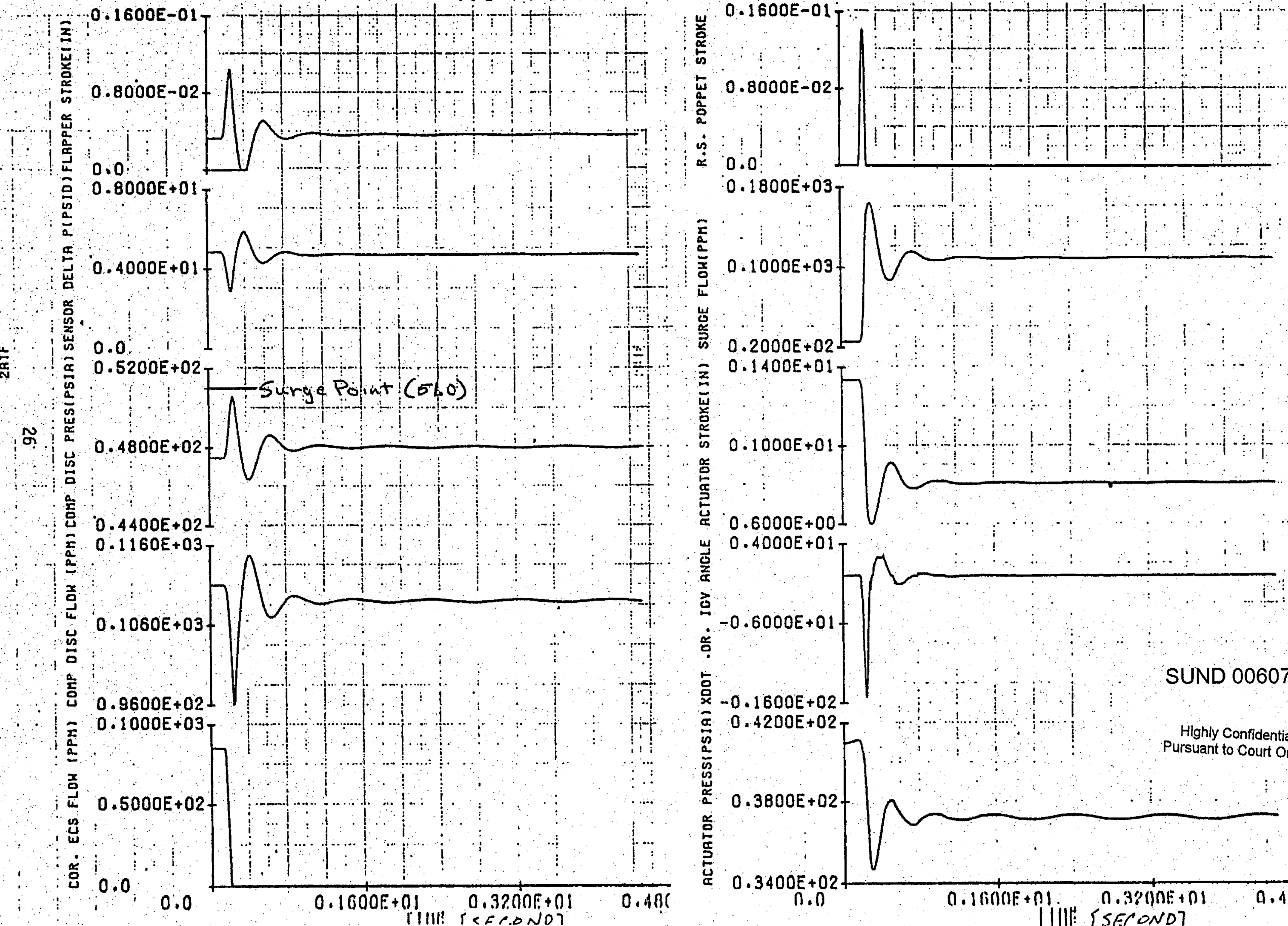
FIGURE 11. TWO ATM . LOW SHUTOFF TRANSIENT
103°F DAY, SEA LEVEL, MAX. MODE, 10% FRICTION



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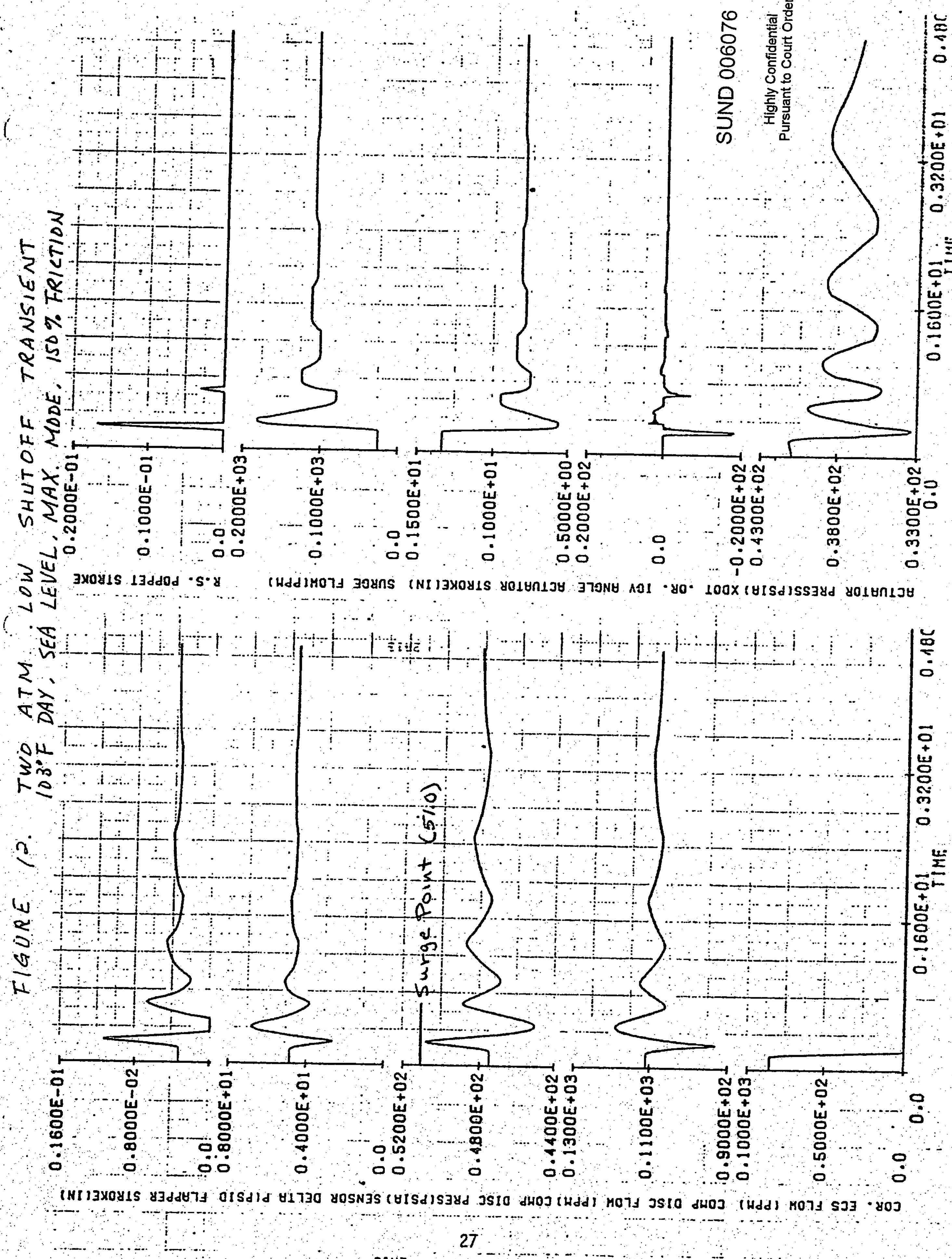
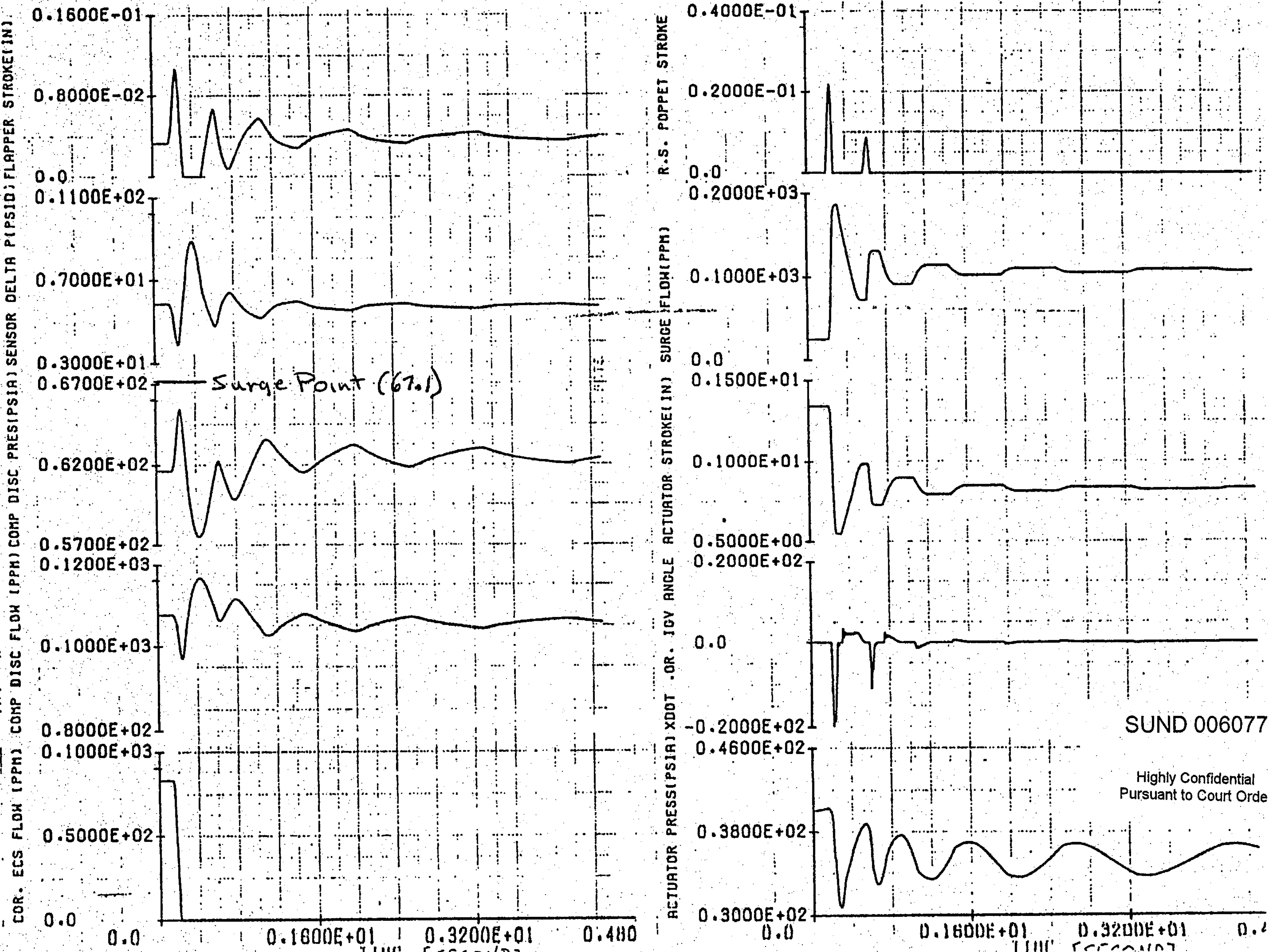


FIGURE 13. TWO ATM FLOW SHUTOFF TRANSIENT
-25°F DAY, SEA LEVEL, MAX. MODE



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